III.C.2 Power Electronics for Solid Oxide Fuel Cells

Objectives

- Simulate an existing AC distribution system.
- Convert the existing AC distribution system to a DC distribution system.
- Investigate the merits of using fuel cell direct current as a power source for a DC distribution circuit replacing an already existing AC distribution circuit.

Accomplishments

- Had a kick-off meeting for the DC distribution study.
- Decided on an actual AC distribution system to be modeled.
- Initiated the modeling of the AC distribution system to be used in the study.

Introduction

Deployment of DC fuel cell power assets creates a DC distribution circuit with highly efficient DC-AC inverters installed to provide AC power. The fuel cell power plants may be deployed in a central and/or distributed scheme. The DC-AC inverters can be deployed at each facility, inside the meter, and/or at a regional level such as a neighborhood. Use of inverter technology will enable integration of numerous functions in addition to power management.

Approach

DC distribution concepts devised and studied in this project shall consider the merit of including the following functions and capabilities into the inverter:

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- Remote digital meter reading
- Smart energy management and control
- Demand-side management and load-shedding strategies
- Real-time price signal decision analysis and load control
- Emergency and casualty power management and control
- Dual power (AC and DC) facility circuits
- Reactive power management
- Energy storage power management
- Integration of local/site power generation management
- Other capabilities

Results

Presently, the project is in the modeling and simulation stage. Results will be obtained after the models are complete and the distribution systems have been simulated.

Conclusions and Future Directions

1. Build system simulation models (October 2006) of
   - An AC distribution system (possibly obtained from a utility)
   - A DC distribution system similar to the AC distribution system above
   - A DC distribution system with distributed generation
2. Compare the DC and AC distribution systems using the models (September 2007) with respect to
   - Cost
   - Energy efficiency
   - Reliability
   - Power quality
   - Pollution emissions
   - Losses
   - Net energy consumption
   - Fuel savings
3. Consider the impact of daily, seasonal, weekend, and holiday/special event load variations (September 2007).
4. Consider the availability to maintain the various fuel cell power modules during light load periods as a means to improve availability performance (June 2007).

5. Assess operational and control changes needed to implement a DC distribution system (March 2007).
6. Answer the following questions (January 2007):
   - What value can be derived by using the third phase wire of a legacy AC circuit for high bandwidth data and communication services?
   - Does having this wire available expand the variety and number viable concepts for circuit status/health monitoring and control?